

The numbers in parentheses given after the numbers of the problems indicate the grades of Russian school to which the problem is recommended. The 8th grade is the first year of chemistry in Russian school and the 11th grade is the last year before graduation.

Task 1. (8–9)

A laboratory assistant prepared a solution of sulfuric acid in water with mass fraction of 30,0%. For this purpose, he took 8,1 g H₂SO₄. After cooling to room temperature, the volume of the solution was 22,16 cm³.

Then the laboratory assistant diluted the solution by adding 13 cm³ of water.

- 1) Calculate the density of the initial 30% solution of sulfuric acid.
- 2) Calculate the mass fraction of sulfuric acid in the solution obtained after dilution. The density of water is 1 g/cm³.

Task 2. (8–9)

A metal sample weighing 5,4 g was completely burnt in oxygen. This gave 10,2 g of the oxide in which the oxidation state of the metal is +3. Write down the equation for the metal reaction with oxygen (the unknown metal can be designated by any letter). Calculate the molecular mass of the metal. Using the Periodic Table, determine the name of the metal.

Task 3. (9–10)

Write down reaction equations required to perform the transformations presented below. Identify the compounds designated by letters (one compound for each letter). Indicate the conditions needed for the reactions to occur. Each arrow corresponds to one reaction.

- 1) Cu → CuCl₂ → **A** → CuO → **B** → CuO → Cu;
- 2) Mg₃N₂ → **C** → NO → **D** → HNO₃ → **E** → N₂O.

Task 4. (9–10)

A mixture of calcium metal and calcium carbonate was annealed in an oxygen flow until the reactions were completed. The weight of the product after cooling was equal to the weight of the initial mixture. Calculate the weight percentages of components in the initial mixture.

Task 5. (10)

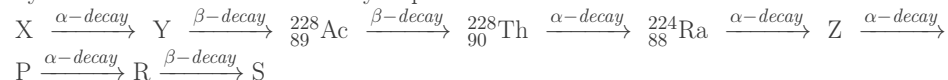
Salt **A** weighing 5,3 g was placed into a vessel containing 182,5 g of hydrochloric acid solution with mass fraction of 10%, and the salt completely reacted. The excess of HCl in the resulting solution was neutralized with 200,0 g of a solution of NaOH with mass fraction of 8%. After completion of the reaction, the final solution contained only salt **B**. Identify the salts **A** and **B**. Calculate the weight of salt **B** in the final solution. Present the appropriate calculations and reasoning.

Task 6. (10–11)

A student was given a mixture of two salts for analysis. He dissolved the mixture in water and it was completely soluble. The subsequent experiments were carried out with separate portions of the solution. On treatment of the solution with silver nitrate, a white precipitate formed. The precipitate was insoluble in acids, but soluble in aqueous ammonia. The reaction of the solution with barium nitrate gave a white precipitate, also insoluble in acids. The addition of alkali (NaOH) to the initial solution yielded a slightly coloured precipitate consisting of two hydroxides, one gradually darkening in air and the other being dissolved in excess alkali. When the initial solution reacted with sodium sulfide, a black solid precipitated formed, which could be dissolved on heating in hydrochloric acid. Which salts could be present in the initial mixture? Propose appropriate pairs of salts. Write down the equations for reactions mentioned in the text.

Task 7. (10–11)

Determine the elements (atomic number, mass number, and name) that are designated by letters in the radioactive decay sequence.



Task 8. (11)

A mixture of ethane and propene of a volume of 11.2 liters (STP) was passed through a vessel with aqueous bromine; after that, the weight of the vessel increased by 12.6 g. Calculate the proportions of components in the initial mixture in volume percent, if it is known that the gas obtained at the outlet of the vessel had a density relative to hydrogen of 18. Present the appropriate calculations and reasoning.

Task 9. (11)

The products of combustion of 1.11 g of an organic compound consisting of three elements were passed successively through tubes filled phosphorus(V) oxide and calcium oxide. The weights of the tubes increased by 0.81 g and 1.98 g, respectively. The gas that was not absorbed in any of the tubes was oxygen. Determine the molecular formula of the compound. Present the possible structural formulae (isomers). It is known that the molecular mass of the compound is less than 80 a.m.u. and that the molecule does not contain rings.

Don't forget to **sign** your work (please, write the card number, your last name, school and grade) before **submitting** the work. You do not have to submit the sheet with the tasks. The tasks, their solutions and the results of the competition will be published at <http://turlom.olimpiada.ru> after November 20.